



Hong Kong Building Commissioning Centre

Building Services Operation and Maintenance Executives Society
Hong Kong Association of Energy Engineers
The Institute of Measurement and Control, Hong Kong Section
Department of Building Services Engineering, Hong Kong Polytechnic University

The Structure of Life-cycle Commissioning Process

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ABSTRACT

Prevention of global warming has now become an critical matter for the way of thinking, under which applying the initial commissioning process to new buildings and retro-commissioning process to existing buildings, in order to secure requested energy and environmental performance, have become a common knowledge for establishing life-cycle energy conservation.

However, combination of these short term commissioning processes from the viewpoint of building life cannot assure the life cycle performance without continuity. Continuity is obtained only by inclusion of on-going commissioning procedure performed by O&M, operating and maintenance personnel, in addition to intermittent re-commissioning process on demand by professional commissioning engineers, because performance of building systems continuously change due to deterioration as well as faulty phenomena, and also the occupancy, building usage and various regulations on energy management are frequently changing.

Keywords: Life-cycle commissioning, continuous commissioning, on-going commissioning, re-commissioning, O&M

1. INTRODUCTION

Proper operation and maintenance of the building services system during lifecycle cannot be achieved only by applying the initial commissioning, to be abbreviated as Cx hereafter, process for new construction or retro-Cx process for existing buildings that have not experienced initial Cx. This is because the building and systems are used for decades long, therefore, not only they themselves degrade, but also building usage, occupancy style and strategy of building maintenance and facility management tend to change. In order to meet these situation change with efficient way of operation, proper Cx strategy to keep the system performance optimal shall be maintained.

Now that global warming issue and energy saving in building sector have come to critical issues, establishing framework of continual monitoring, fault detecting and Cx for optimal operation and maintenance through life-cycle Cx process are indispensable.



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2. CLASSIFICATION OF COMMISSIONING PROCESS

SHASE, Society of Heating, Air-conditioning and Sanitary Engineers of Japan, published its guideline for Cx process in 2004, where the kind and classification of the Cx process was defined as follows. This definition referred the ASHRAE Guideline 0P of 'The Commissioning Process' and also it was referred to by the definition in IEA/ ECBCS/Annex 40 for 'HVAC Cx Process for Energy Conservation'.

Initial Cx process is defined as the Cx process applied to new construction where the total initial Cx process begins at program, or pre-design, phase and ends at one year after hand-over as post-acceptance Cx step. Partial initial Cx is defined as application of Cx for several parts of building production phases except for the total.

Retro-Cx is defined as the Cx for any existing building that has never been commissioned before. It should be noted that Cx here cited is not the Cx only for TAB procedure but the Cx process covering multiple phases, including retro-Cx process. Phases and steps will be defined differently between initial Cx, retro-Cx and re-Cx processes as to be shown later. Thus, either of initial Cx and retro-Cx is the first application of Cx process a building.

In Annex40 there were some discussions on the naming of continuous Cx. According to Prof. Claridge's claim, 'on-going' Cx was adopted instead of continuous Cx that had been the trade mark for Texas State Government. However, the term has formally appeared in the newest ASHRAE Guideline 0-2005 in definition as follows, together with re-Cx.;

Continuous Commissioning Process: A continuation of the Commissioning Process well into the Occupancy and Operations Phase to verify that a project continues to meet current and evolving Owner's Project Requirements. Continuous Commissioning Process activities are on-going for the life of the facility.

On-Going Commissioning Process: A continuation of the Commissioning Process well into the Occupancy and Operations Phase to verify that a project continues to meet current and evolving Owner's Project Requirements. On-Going Commissioning Process activities occur throughout the life of the facility; some of these will be close to continuous in implementation, and others will be either scheduled or un-scheduled (as needed).

Re-Commissioning: An application of the Commissioning Process requirements to a project that has been delivered using the Commissioning Process. This may be a scheduled re-commissioning developed as part of an On-Going Commissioning Process, or it may be triggered by use change, operations problems, or other needs.

With ASHRAE's definition, relation between continuous Cx and on-going Cx is not clear. It looks similar or slightly different each other. In addition, there is no reference on the role of O&M, while without O&M's efforts the building systems will never be maintained optimally in cost efficient way.

In addition, what shall be referred to as the scale of the reference performance is another most

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important thing from the commissioning viewpoint. It is the OPR for initial Cx process and following re-commissioning during a certain length of years. But if you suppose ten years after, initial OPR shall be replaced by ‘running’ performance of the system that shall be identified during operation and re-Cx process, because the initial faults and in-optimality would be almost corrected and tuned more properly to meet the present building use, occupancy state and system characteristics. Therefore, continuous Cx or re-Cx gradually transfer the performance stress from initial OPR to actual performance, or evolving OPR, if the on-going Cx is well defined and well executed. For retro-Cx, there are none of the initial OPR nor the optimal tuning report, so that it begins with identification of the present actual performance and fault detection and diagnosis.

Then the life-cycle Cx is easily defined as the combination of initial Cx and continuous Cx in order to realize minimum energy consumption with the constraints of indoor environmental quality and operating cost. When additional cost for degradations, system failure and low performance would justify system renewal, the building owner should make decision to renew. Information for the decision will have been analyzed and summed up during commissioning and maintenance process.

3. O&M’s ROLE

In the initial Cx process, O&M’s involvement is preferred as early as possible after the start of construction phase, while actually that early participation is quite rare in Japan and, I suppose it true in any other country. The role of giving information from the O&M’s viewpoint shall be done by the owner’s personnel in charge of either facility or property management.

Other than initial Cx, including operation phase of initial Cx, O&M’s role is important, needless to say. In post-acceptance step of initial Cx, also, actual Cx team consists of CA, O&M, building manager and subcontractors when deferred TAB and corresponding FPT works are to be performed. The O&M organization may be as shown in Figure 1.

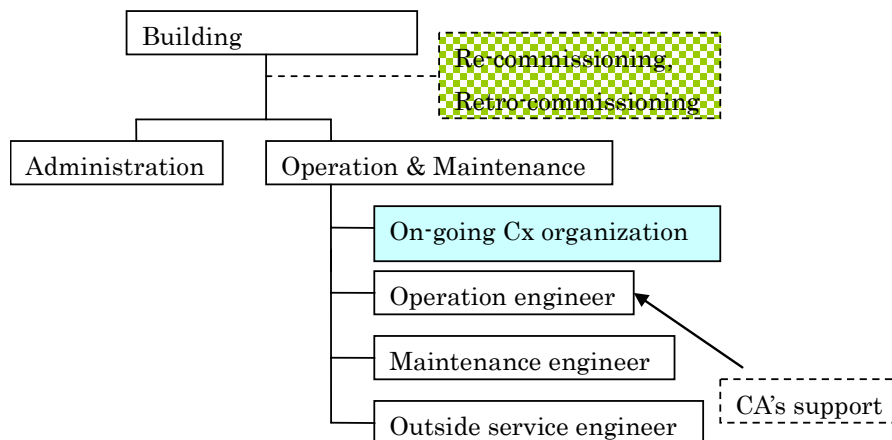


Figure 1 O&M’s organization for building services systems

Once either initial Cx or retro-Cx was performed, O&M staffs will have education and training on the responsible system with the system and maintenance manuals prepared by the Cx

process, so that they will become accustomed with the system and how to operate and maintain. At the same time they can co-operate with CA who were responsible for a foregoing Cx process, so that they are thought capable if they would have motivation for on-going Cx process during ordinary maintenance jobs, with CA's support if necessary. However, as they will not always have professional knowledge on the objective systems, systems will gradually become far from optimal conditions to need the re-Cx to be managed by CA.

4. NEW DEFINITION OF ON-GOING COMMISSIONING AND Re-COMMISSIONING

Thus, the author would like to define the continuous Cx process as combination of on-going Cx performed by O&M as the duty of their job and re-Cx by professional Cx engineer or provider such as CA, CP, etc. to be ordered outside. This will give O&M engineers strong motivation that they participate in energy conservation and contribute to reduce global warming gas emission, and then their professional knowledge grow more and would like to make efforts to reduce energy consumption more and more, which will result in building owner's cost reduction. It is of course that the owner should pay more salary to their employee and the latter will work more effectively and..., the virtuous cycle will begin to circulate.

Figure 2 shows the relations among initial, retro-, on-going, re-, continuous and life-cycle Cxs vs activity level and time elapse. The height of activity level is not always shown realistic, especially initial Cx activity level is shown too low due to too large difference..

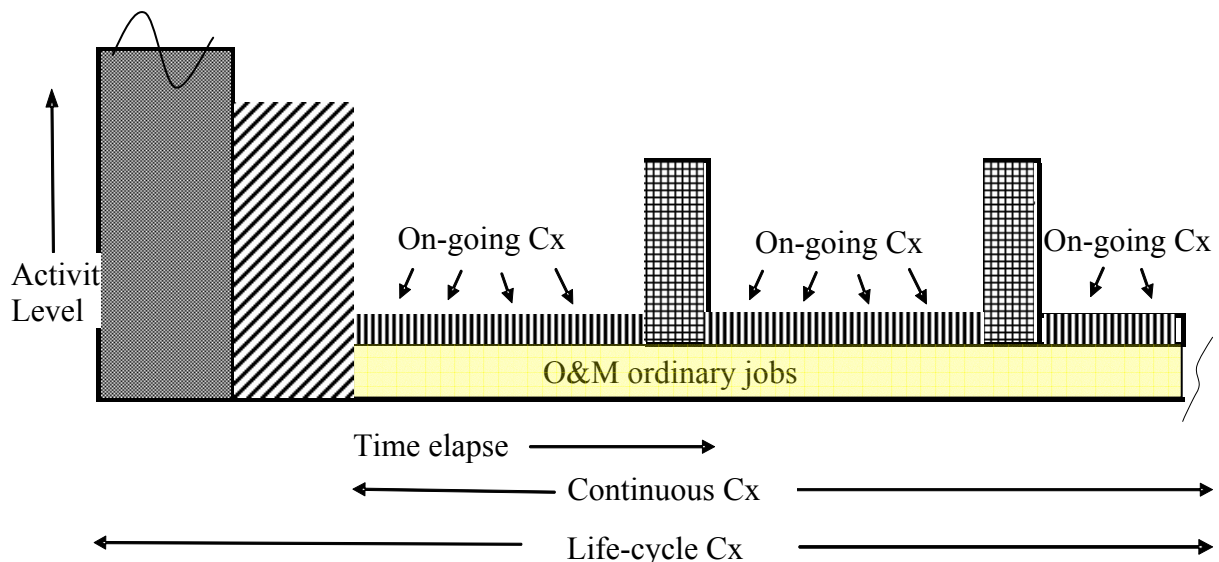


Figure 2 Relation among commission types and structure of continuous Cx

The interval of re-Cx depends upon how well on-going Cx will be executed, or how much building owners expect on their staff and invest for them. Well planned on-going Cx must return advantage of energy and cost reduction to the owner. As for CA or CP, commissioning professionals and commissioning providers, should not think that their businesses will dimin-

ish but rather think that their qualified commissioning technologies would be more requested for high grade tools to diagnose and optimize system operation, controls and performance optimization that cannot be met by O&M. This will also grade up the value of commissioning professionals as well as commissioning process.

5. OUTLINES OF CONTINUOUS COMMISSIONING PROCESS

5.1 On-going Commissioning Process

Object of the on-going Cx is summarized as follows.

- (1) To make sure if outstanding faults remains and any instructions are given to adjust and/or correct during operations, based on the information prepared by foregoing Cx process performed by CA and his professional team, such as initial Cx, retro-Cx and re-Cx.
- (2) To implement corrective actions, if necessary, analyze data before and after corrections and make sure the effect of on-going Cx. It is important to note on the issue log sheet that is used for initial Cx process. This sheet will be filed up for upgrading the expert system.
- (3) To check components' performance using filed manufacturer's submittals applying necessary corrections due to change of operating condition, such as outside air conditions, occupancy, relation between speed variation and energy input corresponding to load variation and to check the COP of subsystem or system.
- (4) To run the expert system or refer system manual to identify and diagnose faults, if any faulty phenomena or failure occur.
- (5) To check and report energy budget and indoor environment quality to the owner, if it meets the OPR, evolving OPR or any other identified performance standard of the building during foregoing Cx process.

The figure 3 shows the on-going Cx process flow. Preparation phase is the phase to coordinate

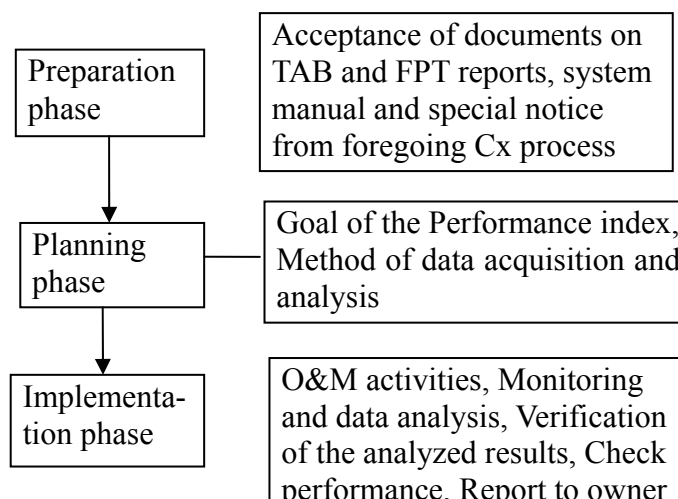


Figure 3 On-going Commissioning Process

Cx team and put all necessary information in order using the documents accepted from foregoing Cx process report. The relationship with facility management and administration de-



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partment of the owner shall be clarified in order that O&M can work dedicated for energy and IAQ commissioning. This phase will be necessary only for the first application after initial or retro-Cx.

Planning phase is required for every on-going Cx after foregoing re-Cx where present system performance will be identified after FDD and fault recovery, optimal tuning and setting of control parameters will be performed and optimal way of operation to meet the present building use and system characteristics will be performed and instructions for O&M shall be prepared. Receiving these information, on-going Cx team shall plan the strategy of Cx till the next re-Cx cycle. Implementation phase is the phase for the O&M team to refrain the work cycle of Plan-Do-Check-Action for any kind of Cx item to improve operation strategy and system performance.

5.2 Re-Commissioning Process

Re-Cx process is the on-demand and periodically done Cx process during on-going Cx, the two of which compose the continuous Cx as frequently cited beforehand. The reason this process is needed is as follows.

- (1) Foregoing initial or retro- Cx process was incomplete due to a certain reason, or so much failure and/or faults existed in the commissioned system that problems will be necessarily handed over to O&M's hands. In that case special style of re-Cx will be needed during the preparation phase of on-going Cx in order to solve problems, identify evaluation indices, establish Cx goal and set up Cx strategy.
- (2) The re-Cx process at the beginning of continuous Cx just after initial or retro- Cx was decided beforehand to implement as one of the facility management policy for the predicted reason just described above.
- (3) It was disclosed that system faults / failure came to frequently occur due to degradation and malfunctions of components, which are not able to be solved only by O&M's on-going Cx process, and that system performance became far from the goal that was set at the planning phase.
- (4) There occurred some kind of big change of state to affect the operation strategy or system modification such as; building use, operation condition, management style, energy regulation, etc.

Anyway it should be remembered that, in case of re-commissioning, priority shall be put on optimization to meet the present state of building and systems rather than initial OPR, especially the building is old enough, e.g. ten years or so. This identification needs not only ordinary operation knowledge and data history but also creative and professional knowledge and tools, so that it is out of O&M's jobs and CA shall be hired. Therefore, he is requested to diagnose the system performance comparing with initial OPR, if any, or previous re-Cx data history and propose a new strategy of operation and maintenance. Figure 4 shows the re-Cx process and procedures.

The process is divided into project definition as pre-phasing stage and three phases for implementation as shown in Figure 4. Detailed procedure to be executed, for example, during

survey step such as preliminary survey and detailed survey and analysis are not the object of the present report.

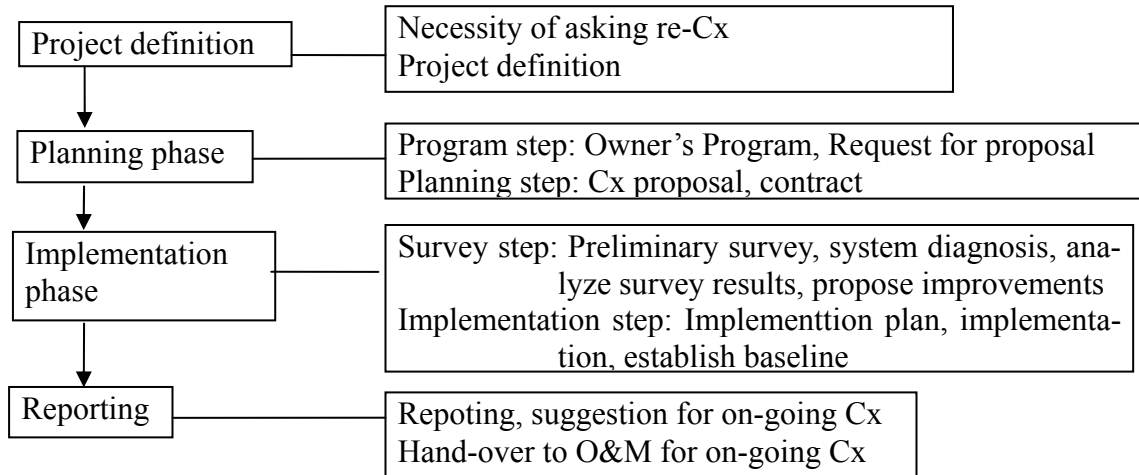


Figure 4 Re-Commissioning Process

6. LIFE-CYCLE COMMISSIONING PROCESS

Life-cycle means the building life from birth to demolition. The birth begins at the programming before design. Before demolition several times of retrofit, may large scale or small scale, and many times of repair and updating systems and components for building services system will take place, because the life of building mechanical and electrical systems is shorter than building structure. As far as the Cx is concerned, the life-cycle Cx consists of initial Cx and continuous Cx, even if some parts of the processes may be partial or none. Figure 5 shows it.

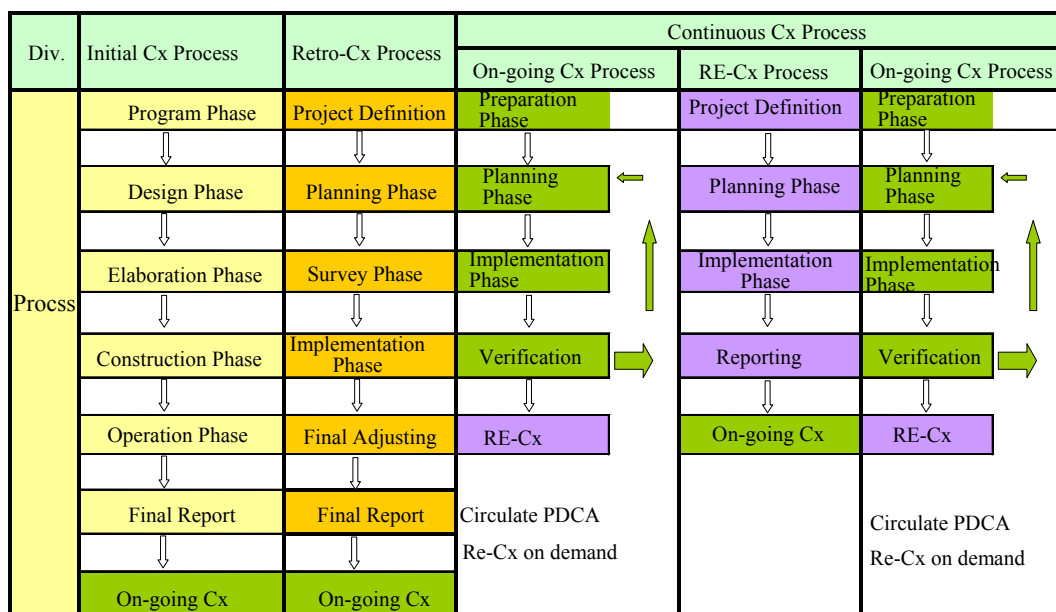


Figure 5 Life-cycle Commissioning



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What is the most important and building owners do not recognize is that initial Cx is most important, because without good system performance, neither energy saving nor quality IAQ are realized, however O&M make efforts. Original design determines the baseline energy and IAQ of the building. In order to achieve energy saving, as well as CO₂ emission reduction as early as possible, retro-Cx, including combination with ESCO scheme, is a short cut way, but with limited solution.

The next important is to apply continuous Cx with the combination of on-going Cx and re-Cx as defined in the present paper. Generally speaking, the O&M's role in the building management has long been neglected and maintenance engineers had little motivation technically as well as economically, because they have not been expected as the main player of energy conservation during the life-cycle. (Situation may be different among countries.) This definition of on-going commissioning depending on O&M personnel will enhance their motivation. Thus, promoting commissioning process application among building industries assist not only the business development of commissioning agent but also upgrading the situation of operating engineers, which provide students with new, interesting and valuable occupation.

7. CONCLUSION

1. The author defined continuous Cx as the combination of on-going Cx and re-Cx.
2. On-going Cx was defined as O&M's activity possibly supported by CA's consultation.
3. Re-Cx was defined as on-demand Cx after either the first application of Cx to new and existing buildings as initial Cx or retro-Cx.
4. On-going Cx and re-Cx was combined to supplement each other on the premise that both sides' Cx reports and data will be used by the other side's Cx activity.
5. The author's definition on continuous Cx is new and a little different from popular guidelines published elsewhere; e.g. ASHRAE Guideline, SHASE Guideline, IEA/ECBCS/Annex40 reports, etc., in including O&M's very important role.
6. The new idea will give O&M staff a strong motivation for their job in contribution to energy saving, global warming gas emission reduction, and economical operation through more professional activity than the past.
7. However, initial Cx followed by continuous Cx, which constitutes life-cycle Cx, is most desirable to achieve the global goal for energy conservation.

8. REFERENCES

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